GROUNDWATER RESEARCH & EDUCATION FOUNDATION

Ground Water Research & Education Foundation

AGENDA... Now Available
(additional modifications will be made)

Ground Water Research & Education Foundation Spotlight series

Two Events… ONE GREAT LOCATION!

July 9-11, 2013
Grapevine, Texas
STRAY GAS
Incidence & Response Forum

WATER MANAGEMENT
Unconventional Oil & Gas Forum
July 9-11, 2013
Grapevine, Texas

Gaylord Texan -- July 9-11, 2013 – Grapevine, Texas

The GWREF is pleased to release the preliminary agenda for two of their Stoplight Series events. For more information and abstract submittal information, please visit www.gwpc.org/events. The three-day event will to be held in Grapevine Texas, July 9-11 2013 at the beautiful Gaylord Texan will include two concurrent special focus conferences including the Stray Gas Incidence & Response Forum and the Unconventional Oil & Gas Water Management Forum.

Stray Gas Incidence & Response Forum

In July 2012 the Ground Water Protection Council, with funding support from the US Department of Energy, sponsored the nation's first forum solely dedicated to the response, investigation, migration, and prevention of water contamination from stray gas in areas of natural gas development. The event, held in Cleveland, Ohio, focused on stray gas research and investigations in the Appalachian Basin and laid the groundwork for subsequent discussions in other natural gas producing regions of the United States and Canada.

This year's Forum, in the Dallas-Fort Worth, TX area, is an opportunity for regulatory officials, the oil and gas industry, consultants and other interested parties in the Gulf Coast Region and Southwestern United States to learn, interact, and develop recommendations that will improve protocols for response to the prevention of stray gas incidents.

Unconventional Oil & Gas Water Management Forum

This event will focus on the challenges of managing and protecting water resources in areas where development of unconventional oil and gas resources is rapidly expanding. The Unconventional Oil & Gas Water Management Forum will spotlight the life cycle of water in exploration and production, including the status of current regulations and the potential risks and challenges associated with safe-guarding and managing water resources, well bore integrity, water quality monitoring, and waste handling and disposal.

Student and Local Government Event Scholarship Application

... As well as-- Event Sponsorship Opportunities, please visit ***www.gwpc.org/events***

July 9-11, 2013
Grapevine, Texas
STRAY GAS
Incidence & Response Forum

EVENT PARTNER Acknowledgments:

On behalf of the Ground Water Research & Education Foundation, THANK YOU for helping make these events possible!

WATER MANAGEMENT
Unconventional Oil & Gas Forum
July 9-11, 2013
Grapevine, Texas

EFD

INTERSTATE Oil & Gas COMPACT COMMISSION

ASDWA
Association of State Drinking Water Administrators

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TEXAS A&M | Institute of Renewable Natural Resources

Ground Water Research & Education Foundation
Spotlight series

These events are part of the Spotlight Series, the technology transfer initiative of the Ground Water Research & Education Foundation.

If you are interested in becoming an **Event Partner**, please contact Ben Grunewald at ben@gwpc.org

Agenda – exact times and names are subject to change

Tuesday, July 9, 2013

8:00

Joint Opening General Session: ***Modern Oil & Gas Production Water Management Issues & other Environmental Challenges***

Industry Perspective – TBA

*Environmental Perspective – **Scott Anderson**, Environmental Defense Fund*

*Rural Landowner Perspective - **Darrell Brownlow**, San Antonio River Authority and South Texas Rancher*

*Research Academia Perspective – **Calvin Finch**, Director, Texas A&M Water Conservation and Technology Center*

*State Regulatory Agency Perspective – **Joe Lee** Pennsylvania Department of environmental Protection*

10:00-noon

Stray Gas Incidence & Response Forum

Moderator – **Scott Kell**, Ohio Oil & Gas

Welcome, & Charge to Participants:

During the Forum in Ohio, it became clear that considerable progress had been made during recent years to improve response to stray gas incidents; however, regulators and industry representatives alike recognized the need to improve response protocols and prevention practices. In order to continue progress, this Forum is designed to draw upon the expertise and encourage input from all attendees. Therefore, each session will be followed by a Q&A session or panel discussion. After each session, attendees are encouraged to make recommendations regarding the following questions:

- Is there a need for more research?
- What factors should be considered in designing useful research?
- Is there a standard or protocol we can agree on?
- If not, who is developing draft protocols for consideration?
- Is there something we are missing regarding this issue?

Introduction to Stray Gas

Presenter - **Fred Baldassare**, Echelon Applied Geochemistry

- Stray gas: its nature and occurrence
- Properties and potential hazards of methane
- Potential sources: Natural and anthropogenic (non-oilfield)
- Potential causes linked to oil and gas exploration and production

Discussion

Mitigation Measures to Protect Public Safety

- Explosive gas detection systems
- Confined space mitigation measures

Abstract 21 Best Suggested Practices to Reduce and Mitigate Problematic Concentrations of Methane in Residential Water Well Systems - **Kevin McCray**, National Ground Water Association (25 min.)

Abstract Emergency Response Procedures and Protocol in Texas – **Dale Kohler**, TCEQ and RRC of TX, TBA (30 min.)

Discussion

Unconventional Oil & Gas Water Management Forum

Moderator – TBA

Welcome, & Charge to Participants

Overview of Water in the Drilling Life Cycle

- Water Acquisition
- Preventing Contamination at the Wellhead
- Well installation and borehole integrity
- Injection, Data Management and Reporting
- Flowback and Produced Water Recycling/Disposal
- Monitoring

The Effects of Unconventional Oil & Gas Development and Water Quantity and Quality, TBA

Abstract 1 Navigating Water Issues in Texas: Water Sourcing, Produced Water Management, Recycling, Spills, and Construction Issues - **David Alleman**, ALL Consulting

Abstract 4 Evaluating Federal, State, and Local Regulatory Trends in Shale Gas Development - **Robert Horner**, Argonne National Laboratory

Discussion

Regulatory/Policy Issues and Updates

- Review of recent regulatory changes
- EPA hydraulic fracturing study update
- Working with local concerns

Panel: EPA (Invited); **Leslie Savage**, RRC of TX; and **Bob Patterson**, Upper Trinity Groundwater Conservation District

12:00

Joint Luncheon –

Opening Remarks: **Mike Paque**, GWPC Executive Director and **Stan Belieu**, Nebraska O&G and GWPC President

Presenter: Impact of Extraction and Electricity Generation Using Shale Gas on Water Resources in Texas, **Bridget Scanlon**, Texas Bureau of Economic Geology

1:30-5:30	*Stray Gas Incidence & Response Forum* *Emergency Response Priorities for Stray Gas Incidents* • Importance of a written Emergency Operations Procedure (EOP) to coordinate multi-agency efforts when a stray gas issue becomes an emergency • Importance of the initial citizen interview when evaluating conditions and determining the preliminary response area • Reconnaissance surveys to define the preliminary area of investigation • Interpreting pre-drill data in light of methane concentration variability • Public and responder safety considerations *Discussion*	*Unconventional Oil & Gas Water Management Forum* *Water Quantity Used, Acquisition & Planning* Moderator - Texas Bureau of Economic Geology (TBA) How Much Water is Used in the Oil & Gas Development Process Abstract 6 Water Use for the Development of Texas Shale and Tight Plays - JP Nicot, Texas Bureau of Economic Geology (invited) CERES--Hydraulic Fracturing Faces Growing Competition for Water Supplies in Water-Stressed Regions Abstract 19 Water Supply Planning, Availability and Opportunities in Oklahoma Kent Wilkins, Assistant Chief of Planning & Management, Oklahoma Water Resources Board Abstract Local Water Availability and Planning Related to O&G Development – Bob Patterson, Upper Trinity Groundwater Conservation District *Discussion* *Resource Expansion* Abstract Traditional and Alternative O&G Production Water Sources (Resource Expansion) – David Alleman, ALL Consulting *Opportunities to Recycle/Reuse* Abstract 10 Treatment Requirements for Produced or Flow Back Water. Treatment Options for Recycling Frac Water. D. Steven Tipton, Newfield Exploration Mid-Continent, Inc. Abstract Produced Water Reuse Case Studies – (Bureau of Reclamation – Invited) Abstract State Water Recycle/Reuse Rules – Leslie Savage, Railroad Commission of TX *Discussion*
6:00-7:30	*Joint Welcome Reception*	

GROUNDWATER RESEARCH & EDUCATION FOUNDATION

The Ground Water Research & Education Foundation (GWREF) is a not-for-profit 501(c) 3 corporation dedicated to promoting research and education related to the protection of ground water. Our mission is to promote and conduct research, education, and outreach, in the areas of development and application of technical systems, pollution prevention efforts related to ground water protection, underground injection technology, and watershed conservation and protection. The foundation is comprised of a board made up of volunteers from government, institutes of higher education, and the public appointed through the Ground Water Protection Council.

Wednesday, July 10, 2013	
8:00-11:30	*Joint Technical Session* *Characterization Aquifer Quality and Identification Oil & Gas Activity Influence* Moderator – Scott Kell, Ohio Oil & Gas *Pre-Drill Surveys and Samples: Maximizing the value of pre-drill assessments* • Pre-Drill Water Quality and Land Use Surveys • Pre-Drill Constituents of Concern (What to sample for) • Pre-Drill water system documentation • Pre-Drill field measurements – the importance of written protocols and sample documentation • Parameter selection considerations Abstract (state initiatives: orphan well initiative, land use surveys and pre drill water system documentation- TBA) Abstract 8 Recommendations for pre-drill water quality testing that is both reasonable and effective - Robert W. Puls, OK Water Survey *Case Studies* Abstract 16 The Occurrence of Methane in Shallow Groundwater from Extensive Pre-Drill Sampling - John Boulanger, AECOM Abstract 18 Real-Time Monitoring for Evaluating Long-Term Variability in Methane in Domestic Water Wells in Northeast Pennsylvania - Charles Whisman, GES *Discussion*
11:30	*Lunch – On your own*
1:00-3:30	*Joint Technical Session Continued* *Characterization Aquifer Quality and Identification Oil & Gas Activity Influence* Moderator - Robert W. Puls, Oklahoma Water Survey *Comprehensive Sampling Techniques , Analytical Techniques, Standards and Protocol* • ASTM D18.26 committee on hydraulic fracturing • Analytical Methods for the presence of Hydraulic Fracturing Fluids • Sampling techniques • Methods to determine if additional sampling is necessary • Interpretation of results Abstract Filtration Technology and Analytical Protocol - Carl Vavra Global Petroleum Research Institute and Johnny Robinson, Hach Company Abstract ASTM Sampling Techniques, Analytical Techniques, Standards and Protocol - Robert W. Puls, OK Water Survey (15 min.) *Case Study* Abstract 20 Evaluation of Common Cement and Bentonite Products used in Water and Monitoring Well Construction (or drilling) for Glycols, Alcohols, and Phenolic Compounds -Bert Smith, Chesapeake Energy (20 min.) *Discussion* *After-Drill Surveys and Samples: Practical and efficient post-activity assessments* Abstract Communicating With the Water Well Owner when Oil & Gas Production is Nearby, Kevin McCray, NGWA (15 min.) Abstract State process to citizen complaint – tiered response approach OH (Scott Kell, Ohio Oil & Gas) Abstract State process to citizen complaint – tiered response approach CO (Peter Gintautas, CO O&G -- invited) *Discussion*

Break 3:30-3:50		
3:50-5:30	*Stray Gas Incidence & Response Forum* Isotopic Forensic Techniques for Methane Source Discrimination Abstract 15 A Geochemical Context for Stray Gas Investigations in the Northern Appalachian Basin: Implications of Analyses of Natural Gases from Quaternary-through-Devonian-Age Strata - Fred J. Baldassare, ECHELON Applied Geochemistry Consulting • Carbon and hydrogen isotopic ratios • Noble gas isotopes as indicators • Use of isotopic ratios in conjunction with compositional analysis • Sample collection methods *Discussion* Physical and Inorganic Water Quality Changes Associated with Stray Gas Presenter - Lisa Molofsky, GSI • Physical changes to groundwater when a stray gas incident occurs • Inorganic chemical changes that may be associated with stray gas • Microbial Driven Association between methane and Groundwater *Discussion*	*Unconventional Oil & Gas Water Management Forum* *Hydraulic Fracturing Flowback, Drilling Fluid and Produced Water Management, Treatment and Disposal Options* • Reuse and Recycling • Zero liquid discharge • UIC Class II and Other common disposal methods for hydraulic fracturing wastewaters and produced water. • Disposal of solids (treatment residuals) in landfills. • Energy/water nexus. • Effects of radioactivity and salt in effluents on downstream drinking water treatment processes. • Use of other water management methods (e.g., ponds). *Discussion Topics* o What is currently known about the frequency, severity and causes of spills of flowback and produced water? o If spills occur, how might hydraulic fracturing wastewaters and produced waters contaminate drinking water resources? Abstract 11 The Case for Recycling Frac Water: Mid-Continent Water Management for Stimulation Operations. D. Steven Tipton, P.E., Newfield Exploration Mid-Continent, Inc. (& combine with) Abstract 22 Risk Concerns Associated with Waste Disposal of Hydraulic Fracturing Fluids by Deep Well Injection - F. Paul Bertetti, Geosciences and Engineering Division, Southwest Research Institute Abstract 2 A Cost-Benefit and Environmental Impact Analysis of Implementing Distributed Energy Sources to Treat Hydraulic Fracturing Wastewater in Texas' Permian Basin. Authors: Yael R. Glazer, University of Texas at Austin *(20 min.)* Abstract 5 Fracturing Fluids from Produced Water - Sarkis Kakadjian, Trican Well Service *Discussion*

<table>
<tr><td colspan="3">Thursday, July 11, 2013</td></tr>
<tr><td>8:00-
10:20</td><td colspan="2">Joint Technical Session
8:00-8:20 Research Partnership to Secure Energy for America (RPSEA) Best Practices for Baseline Sampling/Stray Gas Investigations, Flowback Water Characterization, and Fugitive Air Emissions Measurement - Ann Smith GSI
8:20-8:30 Railroad Commissioner of Texas - TBA

8:30-10:00 Well Installation & Wellbore Integrity
• Well construction standards
• Monitoring to verify integrity
• Investigations and remediation when integrity failure is verified
• GWPC well bore modeling tool
• Surface casing depths to protect usable quality water
Discussion

Abstract 12 Summary of Recent Advances in Well Integrity Analysis for Wellbore Gas Intrusion
J. Daniel Arthur, ALL Consulting
Abstract 9 Well Cementing - D. Steven Tipton, Newfield Exploration Mid-Continent, Inc.</td></tr>
<tr><td colspan="3">Break 10:20-10:40</td></tr>
<tr><td>10:40-
12:00</td><td>Stray Gas Incidence & Response Forum
Stray Gas Prevention: Industry Initiatives
Glen Benge, Benge Consulting
Diagnosis of Well Problems
Direction and Focus of Industry Groups Addressing Best Practices
• API standards for wellbore integrity
• API Standards for sustained annular pressure
• API standards for isolating potential flow zones
Detection and Remediation of Failed Cement Jobs

Discussion</td><td>Unconventional Oil & Gas Water Management Forum
Data Management and Public Availability
• State and Regional Water Well/Water Quality Data
• Chemical registry
• Overview of FracFocus
• RBDMS Hydraulic Fracturing module
• RBDMS Environmental: data management and tracking for analysis
Abstract Overview of FracFocus and Development of O&G Data Exchange - Mike Nickolaus, GWPC
Abstract 3 Summary of FracFocus Public Disclosure Submittals: Process and Results. Bill Hochheiser, ALL Consulting
Abstract FracFocus Training – Rich Haut, Environmental Friendly Drilling
Abstract RBDMS, RBDMS Wellfinder, Wellbore and Environmental: Integrating and Tracking Oil, Gas and Water Data - Paul Jehn, GWPC</td></tr>
<tr><td colspan="3">Lunch – On your own</td></tr>
</table>

1:30-4:00	*Stray Gas Incidence & Response Forum* *Subsurface Gas Migration* • Importance of understanding the three-dimensional geologic framework • Factors affecting subsurface gas migration (dissolved gas; free gas) • Identifying migration pathways • Identifying driving mechanisms • Down hole videography as an investigative tool Abstract 7 The Nuts and Bolts of Conducting a Professional Groundwater and Stray Gas Investigation - **Tom Tomastik**, Geologist, Ohio Division of Oil and Gas Resources Management *Discussion* *Stray Gas Prevention: Regulatory Agency Initiatives* • State regulatory initiatives: well control • State regulatory initiatives: wellbore integrity • State regulatory initiatives: abandoned well *Case Study* Abstract 17 Evaluation of the Relationship between pH and Dissolved Methane Concentrations in Groundwater from Wells in Northeastern Pennsylvania - **Debby Yost**, *Chesapeake Energy* *Discussion*	*Unconventional Oil & Gas Water Management Forum* Moderator – TBA *Contamination Prevention: Site maintenance, inspections, investigations and remediation* • Well site maintenance to prevent contamination • EPA Energy Extraction Inspections/Evaluations • State Inspection Programs Site Investigations Dealing with Historic Contamination -- Oilfield Clean-up Funds and Abandoned/Orphan Well Programs Abstract 14 Well Site Spill Protection: Impacts, Trends and Technologies for Preventing Releases to Water Sources - **Tekla Taylor**, Golder Associates, Inc. EPA Enforcement Initiatives, EPA (Invited) Abstract Comprehensive Oil, Gas and UIC Inspections in Oklahoma: **Bob Griffith**, OCC Abstract 13 Baseline Water Quality Characterization At Four USEPA Retrospective Case Study Areas for the EPA's Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources. **Tad Fox**, Battelle Discussion

Event Registration Information *NOW Open!*

Conference Rates:

Full Conference – Government $445
Full Conference – Non-Government $495
Presenter Discount Rate - $195
One Day Rate - $235
Register online at www.gwpc.org/events

Hotel Registration Information *NOW Open!*

Gaylord Texan

1501 Gaylord Trail, Grapevine, TX 76051
"Ground Water Protection Council" Room Block Code
Conference Room Rate: $139 Reservations: 1-817-778-2000
or, https://resweb.passkey.com/go/GWPC
Special Conference rate is good through June 25th

Printable / Faxable Registration From

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❑ One Day - $235 ❑ Presenter - $195 ❑ Comp*

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Register online at www.gwpc.org/events
Return registration form by fax: (405) 516-4973
Or mail to: Ground Water Protection Council, Attn: Brenda Short, 13308 N MacArthur, Oklahoma City, OK 73142
*Pre-approved required

Acknowledgements: *Event Sponsors and Contributors*

Thank you for caring about Groundwater!

If you are interested in becoming an **Event Sponsor**, please contact Ben Grunewald at ben@gwpc.org

Abstract 1

Navigating Water Issues in Texas: Water Sourcing, Produced Water Management, Recycling, Spills, and Construction Issues.

David Alleman*; J. Daniel Arthur, P.E., SPEC; Damian Zampogna; Brian Bohm (ALL Consulting)

In 2013, there are very roughly 1,750 active rigs drilling wells in the United States. Nearly half of these rigs are drilling wells in one state – Texas! Companies are pursuing development of the Eagle Ford of South Texas, various plays in the Permian Basin, the North Texas Granite Wash, the Barnett Shale of the Fort Worth Basin, the Cotton Valley play of East Texas, and others. Water issues vary in each of these regions. This paper will review how water management issues vary throughout Texas and how industry and regulators are managing these complex issues.

Abstract 2

A Cost-Benefit and Environmental Impact Analysis of Implementing Distributed Energy Sources to Treat Hydraulic Fracturing Wastewater in Texas' Permian Basin.

Yael R. Glazer, Jill B. Kjellsson, Kelly T. Sanders, Dr. Michael E. Webber

Yael Glazer earned her B.S. in Bioengineering from the University of California at Berkeley in 2004. After graduating, she spent seven years working at Genentech, one of the world's leading biotech companies, developing and optimizing manufacturing processes to bring medicines to patients with unmet medical needs. The biotech industry's massive dependence on clean water drove her curiosity about the overall world water crisis. Her interest quickly developed into a passion and led her to pursue a Master's in Environmental and Water Resources Engineering at the University of Texas at Austin.

Improvements in hydraulic fracturing (fracking) and horizontal drilling have enabled rapid development of gas extraction from shale formations. As a result, the U.S. is experiencing a boom in domestic natural gas production that is projected to increase by approximately 25% over the next two decades. While natural gas is relatively clean at the point of combustion, its production presents substantial environmental challenges related to water and wastewater management given the large volumes of water required to fracture a shale formation. In Texas, the majority of wastewater from fracking is disposed via deep well injection, which effectively sequesters the water from future uses.

Distributed onsite wastewater treatment is another technological option: it could decrease wastewater volumes and mitigate water scarcity, which is projected to intensify due to more frequent drought and rising competition among freshwater users, including gas producers. Here, we establish an analytical framework for evaluating the viability of onsite wastewater treatment (and reuse) within the gas sector. Using economic, energetic, and mass balance approaches, we consider the tradeoffs of integrated, co-located natural gas-, solar-, and wind-powered wastewater treatment to reduce water impacts of the energy sector in Texas' Permian Basin.

Abstract 3

Summary of FracFocus Public Disclosure Submittals: Process and Results

Bill Hochheiser*; Mark A. Layne, Ph.D., P.E.; J. Daniel Arthur, P.E., SPEC (ALL Consulting)

Tens of thousands of individual submittals have been made to the FracFocus web site. This type of centralized industry disclosure model is unique and has required involvement from regulatory agencies, E&P companies, non-governmental agencies, service companies, consultants, and the public. This paper will present both information on the results of this massive nationwide effort from multiple viewpoints and will include some of the common challenges encountered by E&P companies and service companies as well as the technical developers of the FracFocus web site.

Abstract 4

Evolving Federal, State, and Local Regulatory Trends in Shale Gas Development

Robert Horner, Argonne National Laboratory

The regulatory landscape of shale gas development has been changing rapidly over the past several years. Most of these changes have occurred at the state level. Several factors, including a statutory exemption for hydraulic fracturing from EPA regulation under the Safe Drinking Water Act, have limited regulation on the federal level. However, federal regulation and policy are currently in the process of being crafted at the Bureau of Land Management, Environmental Protection Agency, and elsewhere. I addition, a number of local governing bodies have been exercising their own authorities to limit or regulate shale gas development, although the extent of local authority has been disputed in some states.

With tens, if not hundreds (counting local governments), of rulemaking and policy-creating entities participating, the evolving landscape of shale gas and hydraulic fracturing policy and regulation can be difficult to follow as a whole. Argonne National Laboratory will characterize this broad landscape of policy and regulation, focusing on recent developments. Instead of going point-by-point through recently enacted state legislation, Argonne will present common themes and regulatory strategies from enacted laws and proposed regulation. These trends and strategies will be analyzed and organized by the three levels of government involved (federal, state, and local), but will also include trends and strategies that cut across all levels of government. This analysis will be presented with a focus on the current and future regulatory trend of shale gas development in the United States rather than a focus on regulatory specifics in a particular area. Developers will always need additional information on regulations specific to their projects. The goal of this presentation will be to provide a wide range of people with interests in shale gas development a useful overview of the current state and trend of shale gas regulation in the U.S.

Abstract 5

Fracturing Fluids from Produced Water

Sarkis Kakadjian, Joseph Thompson, Robert Torres and Frank Zamora

Environmental concerns and public opinion have increased attention regarding the use of fresh water in the hydraulic fracturing industry. Currently, oil companies, operators and service companies acquire fresh water for hydraulic fracturing treatments on the front end and pay to dispose or transport the flowback or produced water on the back end.
A newly developed fracturing fluid system eliminates the upfront costs of purchasing fresh water and significantly reduces back-end costs by transporting flowback and/or produced water to locations for reuse rather than disposal wells located miles, sometimes even states, away from the wellsite.

This new system uses conventional gelling agents and crosslinkers already registered in the FracFocus chemical disclosure registry. The fluid system was developed for temperature ranges between 120°F and greater than 300°F, and field tests have proven shear stability and good proppant transport at 20 BPM through a 1.25 in. sliding sleeve baffle. Breaker schedules can be tailored using instant or delayed crosslinkers in recycled waters with total dissolved solids exceeding 300,000 ppm with hardness exceeding 30,000 ppm. Unlike other fluid systems that are affected by boron, this system can be used in water that contains boron levels exceeding 500 ppm.

The code for recycled water has been broken with this new fracturing fluid system designed to conserve freshwater aquifers and recycle produced and flowback water, reducing disposal costs. This paper includes laboratory testing of the fluid characteristics in untreated produced water from the Bakken and Eagle Ford shales and the outcome of hybrid fluids in field applications. This paper also includes recommendations for field applications, including economic impacts on fracturing fluid systems.

Sarkis Kakadjian is currently a research manager at Trican Well Service LP in the Woodlands, TX.
His current research interests are stimulation and completion, sand control and rheology.
Before joining Trican in 2011, he worked for 6 years as Chief Research Scientist at Weatherford international, Elmendorf, TX. Kakadjian holds a BS degree in Polymer Science from the University of Simon Bolivar, Venezuela and a PhD degree in polymer science from the University of Leeds, England.

Abstract 6

Water Use for the Development of Texas Shale and Tight Plays

JP Nicot, Texas Bureau of Economic Geology

Hydraulic fracturing (HF) has a long history in the state of Texas where are located (1) several established plays, such as the Barnett Shale, (2) plays of recent interest, such as the Eagle Ford or the Wolfcamp, and (3) older plays being revisited such as the Spraberry or the Granite Wash. We compiled current water use for year 2011 (about 82,000 acre-feet) and compared it to an older analysis done for year 2008 (about 36,000 acre-feet). A database compiling state information and providing water use is complemented by industry data to access fresh water consumption, recycled water use, and brackish water use. Gas plays have been recently eclipsed by oil plays resulting in a geographic shift of major HF water use toward south and west of the state where drought periods are frequent. The amount of recycling is still relatively small but the interest in brackish water is growing.

Dr. Jean-Philippe "JP" Nicot, P.E., P.G. is a Research Scientist with the Bureau of Economic Geology, The University of Texas at Austin. His areas of expertise include water resources and associated issues. He recently published several papers and reports detailing the amount of water used for hydraulic fracturing in the state of Texas and is currently researching topics such as natural methane migration to the shallow subsurface and understanding of physical and chemical processes impacting the composition of flow back water. Dr. Nicot holds a Ph.D. in Civil Engineering from The University of Texas at Austin.

Abstract 7

THE NUTS AND BOLTS OF CONDUCTING A PROFESSIONAL GROUNDWATER AND STRAY GAS INVESTIGATION

Tom Tomastik, Geologist, Ohio Division of Oil and Gas Resources Management

Tom Tomastik has BS and MS degrees geology and worked in the Ohio oil and gas industry from 1982 to 1988. Since December of 1988, Tom has been employed by the Ohio Department of Natural Resources, Division of Oil and Gas Resources Management, Underground Injection Control Section. He is responsible for all of the Underground Injection Control (UIC) duties, which include performing independent reviews of applications for Class II saltwater injection and secondary recovery projects, and Class III salt-solution mining wells in Ohio. Additionally, Tom also has conducted several hundred highly complex groundwater conflict investigations involving oil and gas contamination and industrial aggregate mineral dewatering operations.

With the advent of shale play development in the United States and the continued misinformation campaign regarding horizontal drilling and hydraulic fracturing, it is critical for regulatory agencies and the oil and gas industry to conduct a thorough and professional groundwater investigation of any stray gas incident. Stray gas investigations need to be accomplished with the highest level of expertise and experience and must evaluate all potential sources of methane gas migration. This type of investigation warrants a complete evaluation of the local geologic and hydrogeologic conditions, which would include detailed mapping of geologic features and groundwater flow, sampling events, protocols, and chain-of-custody, water well construction and aquifer identification, evaluation of localized oil and gas development and potential legacy issues, and oil and gas well construction and cementing practices.

Stray gas water well contamination issues are not something new and inherent to shale play development in this country. These types of investigations have been conducted by regulatory agencies and the oil and gas industry for decades. Today, however, with the need for sensationalism, the media and internet continue to portray the "lighting of one's faucet" as evidence of the evils of hydraulic fracturing and shale development and the need for federal government intervention.

The "nuts and bolts" of conducting a stray gas investigation will provide details of techniques, methodology, and types of equipment needed to complete a professional investigation and to assist in identifying the source and pathways of stray gas migration. It is crucial that we rely on good science to thoroughly explain the different sources of stray methane gas and dispel the myth that these stray gas incidents are all directly related to hydraulic fracturing and shale development.

Abstract 8

Recommendations for pre-drill water quality testing that is both reasonable and effective

Robert W. Puls, Ph.D., Oklahoma Water Survey

Dr. Robert Puls is Director of the Oklahoma Water Survey and Associate Professor at the University of Oklahoma. Dr. Puls was employed by the USEPA for almost 25 years. He was the Technical Lead for the USEPA Study on Hydraulic Fracturing and Drinking Water Resources prior to his retirement in early 2012. As Technical Lead, he met with numerous industry representatives, non-governmental organizations, federal and state agencies responsible for oil and gas regulatory oversight as well as private citizens. He has a Ph.D. from the University of Arizona and degrees from the University of Washington and the University of Wisconsin.

Several states and other groups have recently put forward guidelines for sampling private water wells where oil and gas operations are occurring as public service information (e.g. Penn State Agricultural Extension; Oklahoma State Agricultural Extension; NGWA/GWPC; Louisiana Department of Health and Hospitals). Several states have recently promulgated regulations that address pre-drill sampling of drinking water supplies/wells (CO, OH, PA, WV). While these are steps in the right direction, there continues to be variation in what is covered under these rules and guides as well as gaps. While leading the field technical portion of the USEPA Hydraulic Fracturing Study in 2010 and 2011, the single most glaring deficiency I noticed in all state programs for oil and gas operations was the absence of any rules or guides for baseline water sampling. When complaints were lodged with state agencies, there was almost never any pre drill data to compare to post drill suspected impacts. The best available data was typically historical regional water quality collected by the USGS, some of which could be decades old. Because of the natural variability of subsurface systems, this data was usually insufficient to allow for comparisons between pre and post drill water quality data.

This presentation will compare and contrast some current state requirements related to the collection of baseline water quality and identify additional needs. The presentation will highlight the following issues:

- Who is paying for and responsible for data collection?
- Who receives the data?
- Who collects the samples?
- What are the sampling objectives?
- What constituents are sampled for?
- Where are the samples collected?
- When are the samples collected?
- How are the samples collected?

Abstract 9

Well Cementing

D. Steven Tipton, P.E., Newfield Exploration Mid-Continent, Inc.

Mr. Tipton earned a professional degree in Chemical and Petroleum Refining Engineering from Colorado School of Mines in 1967 and an MS in Petroleum from the University of Tulsa in 1974. He is a Registered Professional Engineer in Texas and Oklahoma He has more than 45 years' experience primarily in drilling, completion, and production operations throughout the US, Canada, Trinidad and Yemen. He is currently employed by Newfield Exploration in Tulsa, Oklahoma. His primary responsibility is water management for the company's completion operations in the Mid-Continent.

He has made presentations at numerous technical meetings and conferences on water management including SPE Advanced Technology Workshops, The University of Tulsa, the Environmental Protection Agency – Technical Workshops for Hydraulic Fracturing, the OIPA Unconventional Resource Forum, Oil Sands Water Management Initiative, Water Management for Shale Plays, and in house training at Newfield for our new engineers and geoscientists.

Cementing is one of the most critical steps in the drilling and completion (construction) of an oil or gas well. Well cementing technology is a combination of many scientific and engineering disciplines, including chemistry, geology, and physics and petroleum, mechanical and electrical engineering. Each is essential to achieve the primary goal of well cementing – durable zonal isolation.

Primary Cementing: Primary cementing is the process of placing cement in the annulus between the casing and the formations exposed to the wellbore. The major objective of primary cementing has always been to provide zonal isolation in wells to exclude fluids in one formation from migrating to another formation. To achieve this objective, a hydraulic seal must be created between the casing and the cement and between the formation and the cement, while at the same time preventing fluid channels in the cement sheath. Without complete isolation in the wellbore, the well may never reach its full producing potential. Sufficient cement slurry must be pumped into the wellbore's annular space to fill it from the bottom to above the top of the productive formations. Typically, the cement slurry is brought to higher intervals to exclude undesirable fluids from the wellbore, to protect freshwater zones, and to protect the casing from corrosion. Primary cementing requires detailed engineering and application of the best available technology to achieve the desired operational results.

Remedial Cementing: Remedial cementing operations are performed for various reasons. Some of which are to repair a faulty primary cement job, alter formation characteristics such as stopping lost circulation, repairing casing problems, shutting off water production, or abandoning a zone or well. Setting cement plugs may be required when drilling a well and there is a need to side track the original wellbore or to abandon a noncommercial zone.

Cementing Design Considerations
Cement Placement Mechanics
Cement Job Evaluation

Conclusion: This paper will provide an overview of best cementing practices for both primary and remedial cementing operations and focus on the type of wells being drilled in the shale and tight formation resource plays.

Abstract 10

Treatment Requirements for Produced or Flow Back Water

D. Steven Tipton, P.E., Newfield Exploration Mid-Continent, Inc.

Mr. Tipton earned a professional degree in Chemical and Petroleum Refining Engineering from Colorado School of Mines in 1967 and an MS in Petroleum from the University of Tulsa in 1974. He is a Registered Professional Engineer in Texas and Oklahoma He has more than 45 years' experience primarily in drilling, completion, and production operations throughout the US, Canada, Trinidad and Yemen. He is currently employed by Newfield Exploration in Tulsa, Oklahoma. His primary responsibility is water management for the company's completion operations in the Mid-Continent.

He has made presentations at numerous technical meetings and conferences on water management including SPE Advanced Technology Workshops, The University of Tulsa, the Environmental Protection Agency – Technical Workshops for Hydraulic Fracturing, the OIPA Unconventional Resource Forum, Oil Sands Water Management Initiative, Water Management for Shale Plays, and in house training at Newfield for our new engineers and geoscientists.

Water, its use and management is critical to the petroleum industry. It is the most common and heavily used fluid in our business. In every jurisdiction in this country its use is regulated in some manner. The regulations and ownership of water is different in each area in which the industry works. In many areas of the country the use and handling of water have become emotionally charged. For this presentation, I will be concentrating on the water use and reuse in general terms and an overview of water cleanup technologies available to the industry.

Water Recycling Considerations:
Drilling and Completion Program
Exploratory
Development
Infrastructure
Frac pits (Fresh Water)
Recycle pits (Flow Back or Produced Water
Storage for processed water
Transfer lines
Storage Capacity
Untreated water
Processed water
Frac Fluid Chemistry
Slick water
Fresh water linear or cross linked gel
High salt tolerant gel

Review of Eight Basic Technologies:
Dilution
Settling
Filtration
Chemical Precipitation
Electro Coagulation
Distillation

Conclusion: This paper will show how can the industry move from using fresh water to 100% recycled or produced (saline) water? This will be a review of the available technologies that can be used to clean up produced water for reuse.

Abstract 11

Mid-Continent Water Management for Stimulation Operations

D. Steven Tipton, P.E., Newfield Exploration Mid-Continent, Inc.

Mr. Tipton earned a professional degree in Chemical and Petroleum Refining Engineering from Colorado School of Mines in 1967 and an MS in Petroleum from the University of Tulsa in 1974. He is a Registered Professional Engineer in Texas and Oklahoma He has more than 45 years' experience primarily in drilling, completion, and production operations throughout the US, Canada, Trinidad and Yemen. He is currently employed by Newfield Exploration in Tulsa, Oklahoma. His primary responsibility is water management for the company's completion operations in the Mid-Continent.

He has made presentations at numerous technical meetings and conferences on water management including SPE Advanced Technology Workshops, The University of Tulsa, the Environmental Protection Agency – Technical Workshops for Hydraulic Fracturing, the OIPA Unconventional Resource Forum, Oil Sands Water Management Initiative, Water Management for Shale Plays, and in house training at Newfield for our new engineers and geoscientists.

Water, its use and management is critical to the petroleum industry. It is the most common and heavily used fluid in our business. In every jurisdiction in this country its use is regulated in some manner. The regulations and ownership of water is different in each area in which the industry works. In many areas of the country the use and handling of water have become emotionally charged. For this presentation, I will be concentrating on the water use and reclamation for the stimulation of the Granite Wash tight gas reservoirs in the Anadarko Basin and the shale oil reservoirs of the Cana Woodford Shale in the Anadarko Basin. Both areas have evolved as the drilling activity increased and changed. In each area an infrastructure has been created to support Newfield's completion operations and the need for water.

NFX Granite Wash Operations: Newfield's Britt Ranch and Briscoe fields were originally drilled for deep Morrow gas which is a conventional reservoir. Since 2001, Newfield has drilled over 150 vertical Granite Wash tight gas wells. Initially, frac pits were built at each well site. It soon became apparent that having central water supply pits was more economical and as the amount of water being used increased it made sense to begin recycling it. When Newfield started drilling and completing horizontal wells in this area the water usage went from approximately 80,000 barrels per completion for vertical wells to over 250,000 barrels per completion for horizontal wells.

The approach Newfield has taken in its Granite Wash water management is being used as the model for new projects in Western Oklahoma, the Eagle Ford in South Texas, the Wasatch in Eastern Utah and the Marcellus. It is also being copied by other operators in the area.

NFX Woodford Shale Operations: Newfield's Woodford Shale operations are conducted over a 900 square mile area in the Arkoma Basin. The Woodford Shale was initially developed with vertical wells with the best initial production being 1,600 MCFD and the average well's initial production ranged from 300 to 400 MCFD. Newfield began drilling and completing horizontal Woodford wells during the spring of 2005. During the last six years the lateral lengths have increased from 2500 feet to over 10,000 feet with corresponding increases in initial production rates. The average initial producing rate for Newfield's Woodford wells is 7.0 MMCFD.

Once the completion is finished and the well is flowing back, the produced water is trucked to a salt water disposal facility. The Ecosphere equipment is located at one of Newfield's salt water disposal wells and uses the water there as its source. The processed water is stored in in frac tanks until it is needed. At this time only six percent of the frac water is recycled.

Newfield is working on locating a place for recycle pits and being able to use higher chloride water as a frac fluid so that more water can be recycled.

NFX Cana Woodford Operations: For the last two years Newfield has been in the exploration phase of a program in an area covering 10,000 square miles so has only been using fresh water. Newfield has been able to cut our water sue by 2/3 by going from slick water frac's to cross linked gel frac's. With the drought it is quite apparent that another source of water must be found and used. We are working toward recycling the frac water in areas where our infrastructure has grown to a point that it makes economic sense. Reuse of the cross linked gel water presents greater challenges than reuse of the slick water. We are in the process of working out the chemistry and getting pits permitted for the use of recycled water.

Conclusion: Newfield's Granite Wash operation is a prime example of where recycling frac water is environmentally responsible and makes the company money at the same time. This is a win-win for the landowners, the community, and the company.

Abstract 12

Summary of Recent Advances in Well Integrity Analysis for Wellbore Gas Intrusion

J. Daniel Arthur, P.E., SPEC* (ALL Consulting)

Methods used for assessing the integrity of injection wells has been the subject of evaluation by state and federal regulatory officials for decades. Further, assessing the integrity of various other types of wells has been the subject of professionals that range from engineers to geophysics specialists. However, as technology has advanced and where circumstances involve the evaluation of stray gas, utilizing appropriate methods is critical as well as understanding how the presence of gas may impact analysis methods. Failure to use appropriate methods may have disastrous results or likewise may result in unnecessarily compromising protective casing strings in attempts to remediate. This paper will summarize testing and analysis methods and with an emphasis on how methods have advanced.

Abstract 13

Baseline Water Quality Characterization At Four USEPA Retrospective Case Study Areas for the EPA's Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources

Tad Fox, Andrew Barton, Alan Tilstone, and Bernhard Metzger

- Tad Fox is a Research Leader at Battelle with over 23 years experience conducting investigations to characterize and restore groundwater resources.
- Andrew Barton is a Senior Research Scientist at Battelle with over 15 years experience in characterizing and remediating soil, surface water, and groundwater contamination.
- Alan Tilstone is a Principal at Battelle with over 35 years experience providing environmental and earth science and engineering consulting services to the oil and gas industry sector.
- Bernhard Metzger is Battelle's Oil & Gas Practice Leader with over 30 years in oil & gas and environmental consulting.

An initial baseline characterization of surface water and groundwater quality was performed at four USEPA retrospective case study areas. Retrospective case study areas encompass individual or groups of sites under investigation by USEPA in response to alleged water quality impacts resulting from hydraulic fracturing. Baseline characterization focused on two areas within the Marcellus Shale (Washington County and Bradford-Susquehanna Counties, PA) and one each in the Barnett Shale (Wise-Denton Counties, TX) and in the Bakken Shale (Dunn County, ND). Readily available data on applicable regulations, land use, water resources and water quality data were compiled, reviewed and documented for each area. Information pre-dating the onset of unconventional drilling and multi-stage hydraulic fracturing were used to provide an initial characterization of baseline

conditions prior to substantial resource development using horizontal hydraulic fracturing. The compiled historical water quality data indicates preexisting widespread distribution of parameter concentrations higher than relevant screening criteria (e.g.; MCLs, SMCLs). Natural conditions and historical anthropogenic influences (i.e.; land uses) account for the results above the screening criteria. Many of the organic and metal parameters included in the USEPA investigation had no or very limited available water quality information prior to unconventional resource development in the four areas studied. The initial characterization of baseline conditions provides a framework for supporting and assessing information collected by industry or USEPA from the four retrospective case study areas. Available area specific historical water-quality data, land use information, and the application of sound hydrogeochemical principles should be used to inform EPA's research and prioritization of resources. However, rigorous investigations would be required to differentiate potential natural and anthropogenic (including hydraulic fracturing) water quality impacts.

Abstract 14

Well Site Spill Protection: Impacts, Trends and Technologies for Preventing Releases to Water Sources

Tekla Taylor, R.G., CESM, U.S. Energy Services Leader, Golder Associates, Inc.

Tekla Taylor has over 18 years of experience in environmental and water resources management, planning and permitting. She has served on various regulatory stakeholder committees and public outreach committees related to water and environmental protection, and has worked with the oil and gas industry, conducting regulatory reviews and evaluating, developing and implementing strategies and tools for management of flowback and produced water. Ms. Taylor is a member of Western Energy Alliance, Marcellus Shale Coalition, Society of Petroleum Engineers, American Water Works Association and Water Environment Federation and is actively engaged in supporting and promoting innovative water treatment, reuse, and planning.

While there continues to be a significant concern for the impacts of hydraulic fracturing on local water sources, studies and data have shown that most incidents of shale gas drilling contamination are the result of above-ground spills or mishandling of wastewater. These incidents and the fear of their impacts on local communities have resulted in drilling restrictions or bans, increased or evolving regulations and the need for more sophisticated spill control and prevention design. The impact on development not only varies among plays, but can vary from one wellfield to the next in response to local concerns and/or requirements. In response to these concerns many innovative technologies have been designed and implemented in the field as preventive measures. These include the use of mobile water impoundments with secondary leak detection, temporary tanks, alternative transportation and infrastructure and engineered geosynthetic wellpad liners. This presentation will include a discussion of the incidents that have shaped public opinion, the evolution of regulations within the plays to address surface contamination risks, future trends and the technologies that are being implemented to mitigate environmental impacts.

Abstract 15

A Geochemical Context for Stray Gas Investigations in the Northern Appalachian Basin: Implications of Analyses of Natural Gases from Quaternary-through-Devonian-Age Strata

Fred J. Baldassare1, Mark A. McCaffrey, PhD2, John A. Harper, PhD3
1 ECHELON Applied Geochemistry Consulting, 1229 Twelve Oaks Ct., Murrysville, PA 15668
2 Weatherford Laboratories, 3500 Oak Lawn Ave., Suite 205, Dallas, TX 75215
3 Pennsylvania Geological Survey, 400 Waterfront Dr., Pittsburgh, PA 15222

Fred J. Baldassare is a Sr. Geoscientist and the owner of ECHELON Applied Geochemistry Consulting. He has 20 years of experience investigating more than 200 incidents of stray gas migration. He previously served as the statewide consultant on stray gas characterization for the Pennsylvania Department of Environmental Protection. Fred is an experienced researcher who has helped pioneer the application and advancement of isotope geochemistry to identify and distinguish the origin of different gases. Fred has taught

and lectured nationally, and at his alma mater, the University of Pittsburgh, and has co-authored professional papers for peer reviewed journals on the application of isotope geochemistry.

Mark A. McCaffrey is a Senior Technical Advisor at Weatherford Laboratories. He has 22 years of petroleum geochemistry experience, including 11 as founder and President of OilTracers LLC, a firm which Weatherford acquired in 2010. Mark has a BA in Geology (1985) from Harvard University and a Ph.D. (1990) in Chemical Oceanography from the Massachusetts Institute of Technology / Woods Hole Oceanographic Institution Join Program. As an Expert Witness in gas fingerprinting, he has testified (i) in Mississippi State Court, (ii) in Ohio Federal Court, (iii) before the Oklahoma Corporation Commission, and (iv) before the Railroad Commission of Texas.

John A. Harper received an M.S. degree in geology from the University of Florida 1n 1972 and a Ph.D. in paleontology from the University of Pittsburgh in 1977. He joined the Pennsylvania Geologic Survey in the Pittsburgh office in 1977 where he has been involved primarily in data collection and dissemination, and studies of the subsurface geology and reservoir characteristics of Pennsylvania's oil and gas fields. He currently serves as Chief of the Geologic Resources Division, overseeing programs responsible for research, data collection, and evaluation of petroleum geology and engineering, industrial minerals, coal, and both organic and inorganic geochemistry.

As the pace of drilling activity to the Marcellus Formation in the northern Appalachian Basin has increased, so has the number of alleged incidents of stray natural gas migration to shallow aquifer systems.

Prior to the present study, the occurrence and origin of natural gas in the strata above the Marcellus Formation has not been well defined. More than 2,300 gas and water samples were analyzed in the present study for (1) molecular composition, (2) stable carbon and hydrogen isotope compositions of methane and (3) stable carbon isotope composition of ethane. The samples are from Quaternary to Middle Devonian-age strata in a five-county study area in northeastern Pennsylvania. Gas and water samples were collected from (1) 234 gas wells during Mudgas Logging (MGL) programs for wells being drilled to the Marcellus Shale Formation, and (2) 67 private water supply wells during baseline groundwater water-quality testing programs. Regional and local geologic conditions were evaluated from core analyses and published studies.

Evaluation of this geochemical database reveals that microbial, mixed microbial/thermogenic, and thermogenic gases occur in some shallow aquifer systems, and that the gas occurrences pre-date Marcellus Formation drilling activity. The isotope data reveal that thermogenic gases in the Quaternary and Upper Devonian strata are typically distinct from gases from deeper Middle Devonian strata (including the Marcellus Fm). A more detailed review of the geochemistry at the site-specific level also reveals a complex thermal and migration history with gas mixtures indicated by partial isotope reversals ($\delta^{13}C1 > \delta^{13}C2$) in deeper formations and throughout the stratigraphic section above the Marcellus Formation in some areas of the basin.

Abstract 16

The Occurrence of Methane in Shallow Groundwater from Extensive Pre-Drill Sampling

John Boulanger, P.G., AECOM, Pittsburgh, PA, Elizabeth Perry, P.G., AECOM, Chelmsford, MA, Bert Smith, P.G., Chesapeake Energy, Oklahoma City, OK
Mark Hollingsworth, Chesapeake Energy, Oklahoma City, OK

Mr. John R. Boulanger, a Professional Geologist licensed in Pennsylvania and Kentucky, currently serves as a Section Manager for Environmental Sciences in AECOM's Pittsburgh, Pennsylvania office. Mr.
Boulanger received his Bachelor's Degree in Environmental Geology from the University of Pittsburgh and his Master's Degree in Hydrology from New Mexico Institute of Mining & Technology. He currently leads numerous water quality projects throughout the Appalachian Basin and is familiar with water quality issues associated with oil & gas exploration, mining and industrial processes.

On behalf of Chesapeake Energy Corporation, sampling of over 20,000 water wells has been conducted from 2009 to the present, from shale-gas development areas across Pennsylvania, Ohio, and West
Virginia. Sampling was conducted prior to Marcellus/Utica Shale-related exploration, drilling, and production activities in the vicinity of these water wells. The pre-drill samples have been analyzed for methane, ethane, and propane as well as many inorganic parameters.

This presentation will explore the occurrence and distribution of methane in groundwater prior to unconventional gas development. GIS-based mapping and statistics will be used to evaluate the geographic distribution and relationship to bedrock geology. The relationships between methane and other parameters can also help explain methane occurrence, including parameters such as ethane and propane, alkalinity, TDS and major ions, barium, etc.

Better understanding of methane in shallow groundwater will lead to better decision-making when evaluating potential impacts of shale-gas development on water supplies and stray gas occurrence

Abstract 17

Evaluation of the Relationship between pH and Dissolved Methane Concentrations in Groundwater from Domestic Water Wells in Northeastern Pennsylvania

Debby Yost, Nancy Pees Coleman, Ph.D, and Charles Olmsted, P.G.

Debby Yost (debby.yost@chk.com) *is a Senior Environmental Specialist with Chesapeake Energy in Oklahoma City, OK. She is formerly the quality assurance/quality control manager for a large multi-office environmental consulting firm. She has bachelors and master's degrees from Oklahoma State University.*
Nancy Pees Coleman (environconsultants@sbcglobal.net) *is Environmental Toxicologist with Environmental Consultants in Oklahoma City, OK. She has over 30 years experience as an environmental toxicologist and public health professional. She has B.S. from Old Dominion University and graduate degrees from the University of Oklahoma Health Sciences Center.*
Charles Olmsted (charles.olmsted@chk.com) *is an Environmental Supervisor and hydrogeologist with Chesapeake Energy in Harrisburg, PA. He has over 24 years experience as an environmental hydrogeologist. He has bachelor's and master's degrees from Utah State University.*

Dissolved methane has been found in the groundwater from domestic water wells in many locations. The dissolved methane can be naturally-occurring thermogenic, diagnetic, or biogenic or sourced from anthropogenic activities. The presence of dissolved methane in groundwater has been reported to be associated with changes in groundwater geochemistry including changes in pH, alkalinity, and sulfate. Dissolved methane has been found to be temporally variable in domestic water wells regardless of its origin. These variations are attributed to several factors, including changes in atmospheric conditions, physical disturbances, anthropogenic source, the action of water well pumping, active or passive venting of the water well, etc.

It has been suggested by some that changes in pH may be indicative of methane from natural gas wells impacting water wells and therefore, could be used as a potential indicator parameter. The appropriateness of using pH or other water quality parameters as a surrogate were examined using comprehensive and frequent monitoring data for dissolved methane, pH and other water quality parameters available for three groups of domestic water wells from northeastern Pennsylvania. Data were available for (1) wells with no known impact from oil and natural gas drilling activities, (2) wells with known perturbation of natural gas from a natural gas production well, and (3) wells under investigation for complaints related to the presence of increased levels of dissolved methane. Analytical data for these domestic water wells were evaluated for short-term temporal variability in dissolved methane and corresponding pH measurements of the groundwater at the time of sample collection.

Abstract 18

Real-Time Monitoring for Evaluating Long-Term Variability in Methane in Domestic Water Wells in Northeast Pennsylvania

Charles B. Whisman, P.E.[1], Bert Smith, P.G.[2], Debby Yost[2], Charles Olmsted, P.G., CPG[2], Denise Good, P.E.[1], and Richard Wardrop, P.G.[1]

Charles Whisman, P.E. is GES' Chief Technical Officer and has 18 years of industry experience. He leads GES' business strategy, engineering, and technology initiatives. He holds a BS in civil engineering and a certificate in environmental engineering from the University of Pittsburgh.
Bert Smith, P.G. is a Hydrogeologist and Regulatory Specialist at Chesapeake Energy Corporation.
Debby Yost is a Senior Corporate Environmental Specialist at Chesapeake Energy Corporation.
Charles Olmsted, P.G. is the Supervisor of Regulatory Compliance at Chesapeake Energy Corporation.
Denise Good, P.E. is a Principal Engineer at GES.
Richard Wardrop, P.G. is a Principal Hydrogeologist at GES.

Naturally-occurring methane is present in many domestic water wells in northeast Pennsylvania. A significant amount of data is currently being collected by the oil and gas industry as a result of sampling efforts and investigations, much of which is from pre-drilling ("baseline") sampling conducted prior to any drilling activity. However, gaps remain in understanding and quantifying the natural temporal variation in methane concentrations in these wells. This is of significant importance in assessing claims of gas migration when there is nearby anthropogenic activity. This presentation will discuss a research project developed and implemented to gain an understanding of the long-term variability of methane in domestic water wells.

Real-time remote monitoring and data trend analyses are being utilized to understand natural dissolved methane fluctuations in groundwater and correlations between methane headspace concentration in the well annulus and other physical and chemical parameters which could correlate to changes in headspace concentration. Significant efforts were made to select, evaluate, and prepare the wells for the study including borehole geophysics, well equipment upgrades, and installation of water-treatment systems. Descriptions of the customized real-time remote monitoring equipment, array of well headspace and water-quality sensors utilized, and equipment setup will be presented, as well as the associated challenges and logistics. Barometric pressure, water use, water quality, well recharge, water-level fluctuations, and pump cycling are examples of the variables monitored.
Interim results from the on-going study will be presented, including discussion of well construction, geologic settings, water quality, initial trends and findings, and real-time display of data. The usefulness of the data and the accuracy/precision of sensors will be discussed. The long-term study will provide further information to better understand the occurrence and potential causes of methane fluctuations in groundwater and associated water well quality issues in northeast Pennsylvania.

[1]Groundwater & Environmental Services, Inc.
[2]Chesapeake Energy Corporation

Abstract 19

Water Supply Planning, Availability and Opportunities in Oklahoma

Kent Wilkins, Assistant Chief of Planning & Management, Oklahoma Water Resources Board

Kent Wilkins is the Assistant Chief for the Planning and Management Division of the Oklahoma Water Resources Board (Board). Mr. Wilkins has a BS degree in Geology and has been with the Board since 1990. Prior to 1990, Mr. Wilkins worked as a well-site geologist at numerous oil and gas drill sites and as a consulting geologist investigating leaking underground fuel storage tank sites. He is currently responsible for multiple programs at the Board including Water Right Permitting, Water Well Drilling, Floodplain Management, Dam Safety and Technical Studies. Kent has performed technical investigations related to groundwater basin studies, water right permit inspections, groundwater remediation systems and numerous other water projects. He has been involved in environmental hydrogeology and geology for over 20 years. Mr. Wilkins is a Certified Remediation Consultant, Certified Floodplain Manager and a Registered Professional Environmental Specialist. He is a member of the Oklahoma Ground Water Association, National Ground Water Association, Oklahoma Floodplain Managers Association and the Association of State Floodplain Managers.

In 2012, the Oklahoma Water Resources Board completed the Update of the Oklahoma Comprehensive Water Plan (OCWP), the most thorough and inclusive water planning effort ever conducted by the state. The OCWP contains a wealth of technical data and policy recommendations bolstered by an unprecedented level of public input and cutting-edge water science. Serving as an indispensible planning resource for water providers, policy makers, and water users alike, the OCWP identified as priorities -- many currently in implementation -- such initiatives as water/wastewater infrastructure financing, regional planning, instream flows, resolution of state/tribal water conflicts, water conservation and efficiency, expanded monitoring and data collection, and the enhancement of tools to increase water supply reliability. Fifty-year water demand projections formed the basis of numerous OCWP studies that have identified planning basins that could experience future surface water gaps and groundwater depletions as well as specific options to mitigate these potential deficits.

Water required for the oil and gas industry was specifically projected by the OCWP. Numerous oil and gas companies as well as the Oklahoma Corporation Commission provided input regarding estimated demands over the next fifty years for drilling activities, including conventional and horizontal type completions. Because unconventional drilling techniques require more water per completion than do conventional methods, additional sources of water must be considered, including supplies that historically have not been tapped to meet demands. Therefore, expanded opportunities in the use of marginal quality water sources – such as brackish groundwater, treated wastewater effluent, production water from oil and gas operations, and stormwater runoff – have the potential to augment supply in many areas of Oklahoma for drilling and primary completion purposes.

Abstract 20

Evaluation of Common Cement and Bentonite Products used in Water and Monitoring Well Construction (or drilling) for Glycols, Alcohols, and Phenolic Compounds

Bert Smith (Chesapeake Energy), Donald Siegel (Syracuse University). Charlie Carter (TestAmerica Laboratories, Inc.), and Chuck Neslund (EurofinsLancaster Laboratories, Inc.)

Recently, much attention has been focused on the evaluation and testing for glycols, alcohols, phenols, benzoic acid, and 2-butoxyethanol in groundwater samples from water and monitoring wells during investigations of potential impacts. New analytical methods are being developed that have allowed the detection levels for many of these compounds to be achieved in the low parts per billion (ppb) range contrasted to the conventional methods' parts per million (ppm) range. At least one analytical method that allows ppb-range measurement of glycols is not yet widely available in the commercial analytical sector. Most, if not all, of the materials deemed to be acceptable for use in environmental monitoring well or water well construction have either not been tested for these previously mentioned compounds of concern, or to the low ppb ranges now achievable. Such products include lubricants, drilling muds and additives, cement and bentonite annular sealants, and well development additives. Environmental sample preservatives, such as reagent-grade acids, have likewise not been tested for these parameters to the low ppb ranges. To prevent false-positives during investigations, it is necessary to determine the potential contribution these materials may exhibit during laboratory analyses of samples. This presentation will discuss preliminary finding from analytical testing of common bentonites and cements

used in water and monitoring well drilling and completions. Further, information will be presented that discusses the testing of certain reagent-grade preservation acids for some of these compounds.

Abstract 21

Best Suggested Practices to Reduce and Mitigate Problematic Concentrations of Methane in Residential Water Well Systems

Kevin McCray, National Ground Water Association

Bio: Kevin McCray, CAE, is the Chief Executive Officer of the National Ground Water Association (NGWA). In addition to executive director of NGWA, McCray is the chief executive of the National Ground Water Research and Educational Foundation.

McCray has served on a number of water-related advisory groups, including the U.S. Water Resources Export Council, Water Systems Council, U.S. Department of Commerce mission to Australia and New Zealand, U.S. EPA/AWWA Comprehensive Integrated Resource Cooperative Blue Ribbon Panel, Kellogg Foundation Ground Water Education Consortium, the Great Lakes Commission Ground Water Education Roundtable, The American Ground Water Trust and the Ground Water Remediation Technology Analysis Center Advisory Board.

At the National Ground Water Association he has led initiatives to develop industry standards, best suggested practices, and significant upgrades to the voluntary certification program. He led an award-winning effort to develop computer-based business management tools for water well drilling and pump installation contractors.

Abstract: As a benefit to members of the National Ground Water Association and others, the Association is nearing completion, by means of a consensus process, a document to provide water well system professionals (WWSP) with basic knowledge for methane gases that may be encountered during well drilling/construction and suggested practices to reduce and mitigate elevated stray (or fugitive) gas levels. Because of varying geologic conditions and other factors, it is not practical to develop a totally prescriptive guideline.

Subsurface methane may occur dissolved in groundwater or as a gas in the head space of a water supply. Sometimes the concentrations of select gases will prove to be unacceptably high even after careful site selection and well construction, or after cleaning an existing well. The WWSP can recommend cost-effective options to mitigate such problems. For instance, it may be less expensive for the consumer to install an appropriate watertight vented well cap to lower concentrations of a gas than to replace or deepen an existing well or to use a more expensive drilling technology to emplace a new well. Such decisions are site-specific and, thus, based on careful analysis by the WWSP.

For the purposes of the best suggested practices document it is not essential for the WWSP to understand groundwater chemistry or how stray gases form, although there are extensive studies and related publications that document these processes. However, the WWSP will benefit from knowing the geologic settings, as well as the human-related activities that may contribute to gas presence in water well systems.

- Section 1 offers background on the health and safety issues related to stray gases commonly encountered by water well system professionals.
- Section 2 is guidance about how geologic conditions and land-use settings may affect the concentrations of methane in groundwater.
- Section 3 provides a description of well location and construction methodologies to minimize the buildup of methane.
- Section 4 examines well function and stray gases.
- Section 5 deals with post-drilling operations.
- Section 6 describes groundwater sampling methods and treatment options.

Abstract 22

Risk Concerns Associated with Waste Disposal of Hydraulic Fracturing Fluids by Deep Well Injection

F. Paul Bertetti, Ronald Green, and Alan Morris, Geosciences and Engineering Division, Southwest Research Institute, San Antonio, TX

Bio: F. Paul Bertetti is a principal scientist in the Geology and Geochemistry Group of the Geosciences and Engineering Division at Southwest Research Institute. Mr. Bertetti's primary expertise is in field and experimental investigations that seek to evaluate, model, and understand the relationships between the aqueous geochemistry and hydrology of the subsurface. Mr. Bertetti has used hydrochemical data and modeling to understand the hydrogeology of regional aquifer systems and has conducted several studies of groundwater chemistry to characterize flow systems, recharge, and interconnectivity of major aquifers, such as the Edwards, Edwards-Trinity, and Carrizo-Wilcox aquifers in southwest Texas. In addition, he regularly plans and conducts field-based investigations of water quality. As principal investigator for activities related to Radionuclide Transport in the Saturated Zone as part of the U.S. Nuclear Regulatory Commission's high-level waste repository safety program, Mr. Bertetti also conducts laboratory and modeling studies to examine the sorption and ion-exchange behavior of dissolved radionuclides and other constituents on mineral surfaces.

Abstract: Developments in hydraulic fracturing technology have enabled the economic recovery of unconventional oil and gas from tight shale formations such as the Eagle Ford Shale in south Texas. While hydraulic fracturing promises to provide new supplies of oil and natural gas to meet energy demands, there have been several concerns raised regarding the environmental impact of this drilling technology. One potential area of concern is the disposal of liquid wastes. Recent analyses have postulated that the greatest threat posed by hydraulic fracturing activities is wastewater disposal, but assessments of underground injection are lacking. The most common disposal practice in Texas is by deep-well injection. Successful disposal is achieved when the wastewater is safely injected in the targeted horizon without loss of waste into non-targeted horizons and the injected fluids remain in the targeted horizon after injection. Threats to successful disposal of the liquid wastes are encountered when the targeted disposal horizons are former oil and gas formations into which previous exploration and production wells had been drilled but not properly abandoned and when structural features provide potential fast pathways for migration of fluids.

This risk of inadvertent release of hydraulic fracturing wastewater can be mitigated by: (i) avoiding injecting wastewater into depleted oil and gas formations, (ii) expanding the area of inspection to identify improperly abandoned wells, and (iii) developing a comprehensive database of all cases of "breakout" to allow comprehensive assessment of the risk posed by inadvertent wastewater releases. In Texas, groundwater conservation districts are responsible for management and protection of the groundwater resources within their jurisdictions. Effective monitoring of groundwater quality must be tailored to the characteristics of the aquifers of concern but must also account for the complex chemistries of flowback waters and waste brines mixed with drilling additives.